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## Weapons Program Technical Report

### Tommy Morris' Comments on Nuclear Explosive Safety

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## LIST OF ACRONYMS

DA	Design Agency
DoD	Department of Defense
DOE	Department of Energy
HAR	Hazards Assessment Report
IND	Inadvertent Nuclear Explosion
NBE	Nearby Explosion
NEO	Nuclear Explosive Operation
NES	Nuclear Explosive Safety
NESS	Nuclear Explosive Safety Studies
NESSG	Explosive Safety Study Group
NEWS	Nuclear Explosive and Weapon Surety
HEVR	High Explosive Violent Reaction
NEOP	Nuclear Explosive Operating Procedure
NNSA	National Nuclear Security Administration
NWSS	Nuclear Weapon System Safety Studies
OpAmp	Operations Amplifier
OST	Office of Secure Transportation
PIDAS	Perimeter Intrusion Detection Alarm System
PT	Production Technician
TNT	trinitrotoluene

## 1.0 INTRODUCTION

Nuclear explosives and weapon systems require special consideration because of their political and military importance, their destructive power, and the potential consequences of an accident. The special consideration translates into specific requirements promulgated by Department of Energy (DOE) O 452.1E "Nuclear Explosive and Weapon Surety," and Department of Defense (DoD) Directive 3150.02 "DoD Nuclear Weapon System Safety Program." The Los Alamos National Laboratory (LANL) W-Division Nuclear Explosive Safety Office mission is to coordinate LANL participation in Nuclear Explosive Safety Studies (NESS) and Nuclear Weapon System Safety Studies (NWSS); to provide qualified members and advisors to the studies; to liaise with the National Nuclear Security Administration (NNSA), the DoD, other national laboratories, the Nevada Test Site, and Pantex Plant with regards to nuclear explosive and weapon system safety.

These orders and directives define nuclear detonation as an energy release through a nuclear process, during a period of time on the order of 1 microsecond, in an amount equivalent to the energy released by detonating 4 or more pounds of trinitrotoluene (TNT). Through these safety studies all operations with nuclear explosives or nuclear weapons are thoroughly examined to

1. Prevent accidents that could lead to nuclear detonation.
2. Given accidents or incidents, prevent nuclear detonation.

To accomplish this thorough investigation, Hazards Assessments, Fault Trees, Event Trees, and various other models are developed and the results, as well as basis and assumptions, are challenged and debated to provide some assurance that an accidental nuclear detonation is not a credible event.

I started at LANL in September 1996 and was the Project Leader for Nuclear Explosive Safety (NES) from December 1998 until June 2016. As a staff member in W-Division NES Office my responsibilities include development and presentation of LANL positions on the design safety of nuclear weapons as well as participating as a Nuclear Explosive Safety Study Group (NESSG) member during reviews of nuclear explosive operations to be conducted at the Pantex Plant. Before joining the Laboratory, I worked for Battelle Pantex and Mason & Hanger Corporation at the DOE Pantex Plant, where I served as the Department Manager for Nuclear Explosive Safety for a few years. Before I was the Department Manager, I was Nuclear Explosive Safety Engineer primarily responsible for electrical equipment safety review (Master Tester List, Master Equipment List, and Facility Equipment). Before going to NES, I was an engineer in Tester Design Engineer, where I was the lead engineer for the W89 Testers. I started my career as a Plant Design Engineer in the electronic surveillance group, which was responsible for the Perimeter Intrusion Detection Alarm System (PIDAS), Central Guard Station, and some other systems.

The current W-NES Office Leader, Paul Peterson, asked me to put together some comments about Nuclear Explosive Safety in a similar vein that Ken Pierce put together a narrative for me.<sup>1</sup> As Ken noted, it is difficult to separate the Nuclear Explosive and Weapon Surety (NEWS) program from Nuclear Explosive Safety Studies (NESS). In order to comment on NESS, I'll start with some comments on the NES standards.

## 2.0 EVOLUTION OF THE NUCLEAR EXPLOSIVE SAFETY STANDARDS

The following table is a brief summary of the Nuclear Explosive Safety (NES) Standards evolution. Originally, the NES standards just copied the DoD Surety Standards<sup>ii</sup>. Also from the DoD Nuclear Weapons Surety Program comes the requirement that Nuclear Weapon Systems will be evaluated throughout their DoD life cycles for compliance with the four DoD nuclear weapon system surety standards through a formal study and review process. Starting with DOE O 5610.11, the now NNSA NES Standards started diverging from the DoD with the addition of the 5<sup>th</sup> Standard. The current NES Standards in DOE O 452.1E have diverged so much that they are no longer traceable to the DoD Surety Standards.

**Table 1. Nuclear Explosive Safety Standards Evolution.**

NES Standards Evolution by Order		
Order	Standards	Comments
<i>AEC O56 "Program to Prevent Accidental or Unauthorized Nuclear Explosive Detonation"</i>  ~1961 to 1980	To assure that all vital areas of concern are considered in the development of nuclear safety rules and procedures for Atomic Energy Commission (AEC) operations, the adequacy of safety rules, procedures, and equipment shall be measured against the following safety standards	Same as DoD Standards with the paraphrase of explosive safety goal.
	1) There shall be positive measures to prevent nuclear explosives involved in accidents or incidents from producing a nuclear detonation. (In addition, a goal of the program is to assure that everything practicable has been done to prevent nuclear explosives in accidents or incidents from producing a high explosive detonation)	
	2) There shall be positive measures to prevent the deliberate unauthorized prearming, arming, launching, firing, releasing, or detonating (high explosive or nuclear) of a nuclear explosive	
	3) There shall be positive measures to prevent the accidental or inadvertent prearming, arming, launching, firing, releasing, or detonating (high explosive or nuclear) of a nuclear explosive	
	4) There shall be positive measures to assure adequate security to prevent unauthorized access.	
<i>DOE O 5610.3 "Program to Prevent Accidental or Unauthorized Nuclear Explosive Detonation"</i>  1980–1990	To assure that all vital areas of concern are considered in the development of nuclear safety rules and procedures for DOE operations, the adequacy of safety rules, procedures, and equipment shall be measured against the following safety standards	Changed AEC to DOE in preamble, kept the standards the same including explosive safety goal

NES Standards Evolution by Order		
Order	Standards	Comments
DOE O 5610.11 "Nuclear Explosive Safety" 1990–1997	All DOE nuclear explosive operations, including transportation, shall be evaluated against the following qualitative standards (in the context of this Order, the word "prevent" means to minimize the possibility; it does not mean absolute assurance against):	Circa 1990, added the 5 <sup>th</sup> Standard on Pu Dispersal.
	1) There shall be positive measures to prevent nuclear explosives involved in accidents or incidents from producing a nuclear yield	This begins divergence from the DoD Standards
	2) There shall be positive measures to prevent deliberate prearming, arming, or firing of a nuclear explosive except when directed by competent authority	
	3) There shall be positive measures to prevent the inadvertent prearming, arming, launching, firing, or releasing of a nuclear explosive in all normal and credible abnormal environments	
	4) There shall be positive measures to ensure adequate security of nuclear explosives pursuant to the DOE safeguards and security requirements	
	5) There shall be positive measures to prevent accidental, inadvertent and deliberate unauthorized dispersal of plutonium to the environment.	
DOE O 452.2A "Safety of Nuclear Explosive Operations" 1997–2001	All DOE nuclear explosive operations shall meet the following qualitative Safety Standards to prevent unintended nuclear detonation or fissile material dispersal from the pit. There shall be positive measures to:	Rewrote and reordered the NES Standards. Diverged further from DoD Standards.
	1) minimize the possibility of accidents, inadvertent acts, or authorized activities that could lead to fire, high-explosive deflagration, or unintended high-explosive detonation	
	2) minimize the possibility of fire, high-explosive deflagration, or high-explosive detonation given accidents or inadvertent acts	
	3) minimize the possibility of deliberate unauthorized acts that could lead to high-explosive deflagration or high-explosive detonation	
DOE O 452.2B "Safety of Nuclear Explosive Operations"  2001–2005	Nuclear Explosive Safety Standards. All nuclear explosive operations shall meet the following qualitative safety standards to prevent unintended nuclear detonation or fissile material dispersal from the pit. There shall be controls to—	LANL objected to change of "positive measure" to "control."
	No change to the standards	

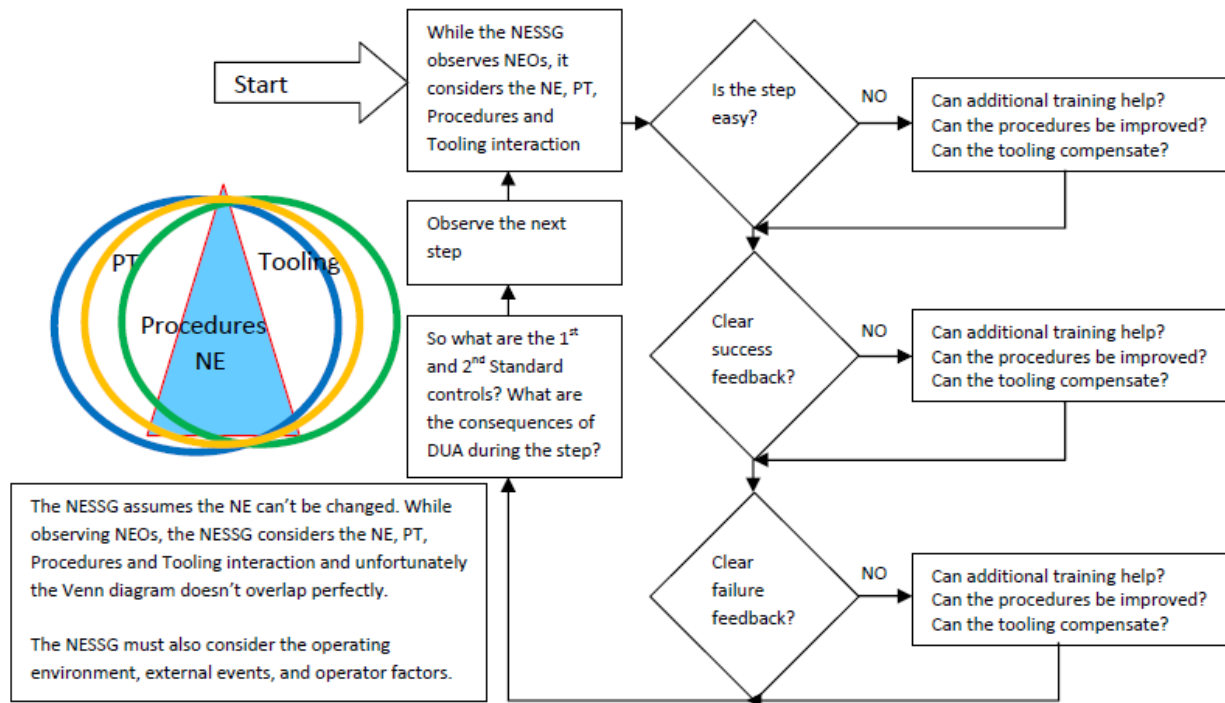
NES Standards Evolution by Order		
Order	Standards	Comments
DOE O 452.2C "Nuclear Explosive Safety"  2005–2009	DOE NES Standards. All NEOs must meet the following qualitative NES Standards to prevent unintended nuclear detonation or fissile material dispersal from the pit.	Minor change to make "standards" complete sentences but still need the preamble for completeness.  Added a postamble of explanation
	1) There must be controls to minimize the possibility of accidents, inadvertent acts, or authorized activities that could lead to fire, high explosive deflagration, or unintended high explosive detonation.	
	2) There must be controls to minimize the possibility of fire, high explosive deflagration, or high explosive detonation, given accidents or inadvertent acts.	
	3) There must be controls to minimize the possibility of deliberate unauthorized acts that could lead to high explosive deflagration or high explosive detonation.	
	The adequacy of controls is established by employing multiple layers of defense. It is beneficial, and preferable, for controls to interrupt the chain of events as early as possible and as often as practical to raise confidence in the overall effectiveness of the control set. A primary target of NES controls is to protect nuclear explosive main charge high explosive (HE) from insults capable of producing HE detonation or deflagration, including those arising from initiation of main charge detonators.	
DOE O 452.1D  2009–2015	Nuclear Explosive Surety Standards. All DOE nuclear explosives and nuclear explosive operations must meet the following qualitative surety standards.	Consolidation of 3 standards down to 2 and incorporation of DUA into the first two standards added obliquity. Los Alamos National Laboratory (LANL) Comments on NA-121.2 Proposed Surety Standards (U) LA-CP-07-0989, objects to use of prevent and commenting about the need for 3 paragraphs of postamble explanation. The labs were not asked to participate in the formulation
	1) Nuclear explosive operations must have controls that prevent adverse environments and unauthorized acts that could lead to unintended nuclear detonation or main charge HE detonation/deflagration.	
	2) Nuclear explosive operations must have controls that prevent unintended nuclear detonation and main charge HE detonation/deflagration, given an adverse environment or unauthorized act.	
	Application and Intent of the Surety Standards. a) The term "prevent" implies an absolute assurance, which cannot be guaranteed and is rarely achievable. Nonetheless, prevention of unintended/unauthorized nuclear detonation and unintended main charge HE detonation/deflagration is a primary goal in the design and performance of nuclear explosive operations. The objective is to drive the likelihood of the specified consequences as low as reasonably achievable. b) A primary target of nuclear explosive surety controls is to protect nuclear explosive main charge HE from	

NES Standards Evolution by Order		
Order	Standards	Comments
	<p>environments capable of initiating it, including those environments to which main charge detonator cable assemblies are exposed. Adequacy of controls must be established through application of the concept of defense-in-depth (redundancy, diversity, safety margins, etc.) in all stages of nuclear explosive operations. First standard controls prevent or interrupt accidents before environments are created that could initiate detonation/deflagration of main charge HE. Second standard controls protect the main charge HE from initiating environments or mitigate the environment to a level that is incapable of initiating the main charge.</p> <p>c) "Environment" means the aggregate of surrounding conditions, circumstances, objects, and influences. An "adverse environment" is one that is capable of producing an unwanted response. The adverse environments of interest for the Surety Standards are those that, if unmitigated, might lead to nuclear detonation or main charge HE detonation/deflagration. Examples include anything that introduces unintended or unauthorized energy hazardous to a nuclear explosive such as human error; deliberate acts; equipment malfunction; other accident initiators, precursors, or sequences; and the conditions those events create.</p>	<p>of these proposed standards, only to comment after their formulation.</p> <p>Another change due to the order system was to only state a requirement once and not repeat it in other documents. So, the standards are only stated in the top-level order, and for a complete set of definitions, one may need several orders.</p>
DOE O 452.1E  2015–202X	For all nuclear explosive operations, there must be a positive measure that will effectively interrupt each credible scenario that leads to an unintended nuclear explosive detonation or main charge High Explosive Violent Reaction (HEVR).	No preamble. The labs were not asked to participate in the formulation of these proposed standards, only to comment after their formulation.
	For all nuclear explosive operations, there must be a second independent positive measure that will effectively interrupt each credible scenario that leads to an unintended nuclear explosive detonation or main charge HEVR given the first measure fails.	
	Kept 3 paragraphs of postamble.	The change to HEVR has potential unintended consequences.

Reordering the NES standards from the DoD Standards is the greatest mistake that I've been part of. Just as NNSA refuses to do step 5 of Integrated Safety Management (ISM), there is an institutional refusal to examine Nuclear Explosive Operations (NEOs) beyond the 1<sup>st</sup> NESS Standard<sup>iii</sup>.

### 3.0 EVALUATIONS USING THE NES STANDARDS

Figure 1 is my model<sup>iv</sup> of how the NESSG evaluates NEOs using the standards. NEOs are a combination of the tooling, procedures, and human interaction on the nuclear explosive. The NESSG's evaluation, as depicted in Figure 1, of NEOs cannot be perfect because of trainer limitation or in the case of OSRs, sample size limitations.



**Figure 1. My model of NESSG evaluation of NEO procedural step before DOE O 452.1E Standards.**

But the facility boundary conditions and interfaces with the Nuclear Explosive Safety Master Studies is missing from this figure. (George Box was right!)

I think the best discussion of NESSG evaluation of the current standards comes from the 2021 Over-the-Road (OTR) NESS<sup>v</sup>. The challenge with the new standards is how can all possible accident be exhaustively documented with two independent sets of positive measures?

The Office of Secure Transportation (OST) offsite transportation environment is dynamic and unpredictable. This environment has external mechanical, electrical, thermal, chemical and other hazards in close proximity to the OST convoys, which are outside the control of NNSA. For offsite transportation NEOs, these hazards cannot be eliminated<sup>vi</sup>.

However, DOE O 452.1E 1.b.(1) states the first objective of the NEWS program: "To prevent accidents involving US nuclear weapons and nuclear explosives". Section 4.a. Lists the Nuclear Explosive Surety Standards. The First Standard, 4.a.(1) states "For all nuclear explosive operations, there must be a positive measure that will interrupt each credible scenario that leads to an unintended nuclear explosive detonation or main charge High Explosive Violent Reaction (HEVR)." The Second Standard, 4.a.(2) states "For all nuclear explosive operations, there must be a second, independent positive measure that will effectively interrupt each credible scenario that leads to an unintended nuclear explosive detonation or main charge HEVR given the first measure

fails.” To meet the requirements of DOE O 452.1E, OST has to implement these positive measures in this unpredictable environment.<sup>vii</sup>

The OTR NESSG concluded the OST administrative controls (e.g., railroad crossing procedure, severe weather avoidance, requirements for Federal Agent driver rest and rotation, etc.) are the First Standard positive measures but these positive measures cannot eliminate the potential for accidents. The Second Standard positive measure(s) are the design feature(s) of the SGT/MGT, including the cargo restraint system. Given an accident occurs, the First Standard positive measure(s) will have failed. Then NES relies on the Second Standard positive measure(s) provided by the SGT/MGT. The NESSG also envisions accident scenarios based on newspaper articles, Facebook posts, etc. that are beyond the withstand capability of the SGT/MGT. In these instances, the NNSA will have to rely on the nuclear safety design (Enhanced Nuclear Detonation System and One-Point Safety) of the weapon to prevent an unintended nuclear explosive detonation.

My 'ism for OTR is that it is the most boring NEO but has the most interesting environments. I think the 2019 OTR NESSG did a great job sorting out the NES Standards for OTR:

1. The Federal Agent procedures are trying to prevent an accident, the first standard is met.
2. The conveyance (SGT or MGT) has significant accident withstand capability and is truly independent of the controls used to meet the 1<sup>st</sup> Standard, therefore 2<sup>nd</sup> Standard mostly met given an accident.
  - It is easy to envision accident scenarios that cause the “barrier” of the conveyance to fail. In these situations, there is only the nuclear explosive response to the combination of environments that breach the conveyance.

The OTR paradigm doesn't work for Pantex Plant operations because the operations are the most interesting NEOs, but the most boring environments.

The independence clause of 2<sup>nd</sup> NES Standard makes it incredibly difficult to meet. At present, my thinking is that the tooling and procedures are the set of 1<sup>st</sup> NES Standard positive measures. The drop-catch features in various lifting fixtures no longer count as 2<sup>nd</sup> NES Standard positive measure because they're not independent of the rest of tool. I suggest that the production technicians (PTs) are the control feature of procedures. Therefore, my current idea is that the facility procedures that manage the operating environment are the 2<sup>nd</sup> NES Standard positive measures (essentially, the Master Study interfaces). Just like with OTR evaluation, the NESSG can envision scenarios where given the set of 1<sup>st</sup> Standard Positive measure fail, the 2<sup>nd</sup> NES Standard positive measures may also be in an “upset condition”. Then all the NESSG has is some sort of “mitigated” weapons response.<sup>1</sup> Since both the 1<sup>st</sup> Standard and 2<sup>nd</sup> Standard positive measures rely on procedure adherence, are they independent as required by the order? Maybe the answer to this question is buried in understanding control effectiveness and considering the Production Technicians (PTs) not as hazards but as the operations amplifiers with feedback loops. The PTs are like the Operations Amplifier (OpAmp) in a simple electronics circuit, they provide this “go” signal but also the feedback necessary to control and/or stop the process. The NESSG

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<sup>1</sup> At present, the Design Agencies provide 10 CFR 830, “Nuclear Safety Management” compliant weapons response rules for unmitigated hazards. The Production Plant Contractor uses these rules to develop Hazard Assessment Reports.

relies on the PTs to stop operations when anything is amiss—whether it is the facility or Nuclear Explosive Operating Procedures (NEOPs) or tooling.

### 3.1 Items of NESSG Concern During Evaluations

- Strong Shock Sources

The DOE/NNSA is concerned about the Nearby Explosion Phenomenon. Nearby Explosion (NBE) is the phenomenon of the detonation of a high explosive (donor) that results in blast effects reaching a nearby nuclear explosive (acceptor). The consequences of the blast effects on the accepting nuclear explosive may range from inconsequential to a nuclear explosive detonation (>4lb TNT equivalent yield). The NESSG has to pay close attention to NBE since the consequence may include HEVR in the acceptor. While the physics labs have good high explosive detonation models for strong-shock sources, they have very little if any high explosive models for HEVR response.

- Electrical Sources

The Primary detonators are safer with the fireset detached during an accident scenario, since the fireset's design function is to convert incompatible electrical energy into the compatible electrical energy for the detonators. This is why DOE O 452.2F puts so much attention on electrical testers, mechanical equipment powered by electricity, and even the facility equipment that should never come into contact with a nuclear explosive. This is why the two-person concept has been expanded to electrical testers and even to Metrology Calibration of electrical testers.

## 4.0 NESS REPORTS

The NESSG documents the results of their evaluation against the 1<sup>st</sup> and 2<sup>nd</sup> NES Standard and other NES criteria (i.e., DOE O 452.2F and SD 452.2B requirements). Since Master Studies don't evaluate specific NEOs, those reports don't have a statement about the NES Standards because the focus is on facilities and/or programs that define the boundary conditions for the program-specific NESSG evaluations. The NESSG reports don't include formal accident scenario development or positive measure effectiveness evaluations. The only place that develops accident scenarios is in the 10 CFR 830 compliance Hazards Assessment Report (HAR) but in Attachment 4 of Supplement Directive 452.2B (NNSA SD 452.2B), the second sentence of paragraph 4 has the following lead-in, "While it is not a NESSG function to evaluate the accuracy and completeness of safety basis documentation, ..." and this phrase is generally referred to as, "The NESSG is not the HAR police." So, there are endless debates on the credibility of an NES issue (e.g., Nearby Explosion).

### 4.1 10 CFR 830 "Nuclear Safety Management"

10 CFR 830, "Nuclear Safety Management" was initially promulgated circa 1995 but included a statement that operations covered by Nuclear Explosive and Weapon Surety (NEWS) Program were excluded. At DOE/Albuquerque Operations Office, suddenly every Division was part of the NEWS program. At the start of the new millennium 10 CFR 830, "Nuclear Safety Management" was revised to remove the NEWS exclusion statement and add a couple of safe harbor methods for nuclear explosive operations hazard

assessments. Just as suddenly, every DOE/AL Operations Office Division<sup>viii</sup> returned to badmouthing the NEWS program and questioning the NEWS program's existence since 10 CFR 830 was in place.

The foundational product of 10 CFR 830 is the Documented Safety Analysis<sup>ix</sup>(DSA).

10 CFR 830 says documented safety analysis for a Hazard Category 1, 2, or 3 DOE nuclear facility must, as appropriate for the complexities and hazards associated with the facility:

Evaluate normal, abnormal, and accident conditions, including consideration of natural and man-made external events, identification of energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials, and consideration of the need for analysis of accidents which may be beyond the design basis of the facility.

For Nuclear Explosive Operations the unique nuclear hazard is inadvertent nuclear explosion (IND). So substituting IND for criticality, the rule would read:

With respect to a nonreactor nuclear facility with fissionable material in a form and amount sufficient to pose a potential for an inadvertent nuclear explosion (IND)<sup>x</sup>, define a nuclear explosive safety program that:

- Ensures that operations with fissionable material remain Nuclear Explosive safe under all normal and credible abnormal conditions;
- Identifies applicable nuclear explosive safety standards; and
- Describes how the program meets applicable nuclear explosive safety standards.

Therefore, 10 CFR 830, "Nuclear Safety Management" doesn't replace NEWS program, it empowers the NEWS program. Through the Order process, DOE O 452.1E, "NEWS Program" and DOE O 452.2F, "NES" can be changed but they can't be eliminated.

Driven by 10 CFR 830, operational safety is driven by hazard assessment. This methodology identifies hazards and implements controls to eliminate or mitigate the identified hazard. Thus a hazards assessment will identify operational steps that are perceived to be high explosive detonation hazards and implement operational controls (because we can't eliminate high explosives from nuclear explosives) to prevent an accidental high explosive detonation. Therefore, the design safety one-point safety requirement will never be derived as necessary from an operational hazards assessment.

Additionally, since the removal of the NEWS exclusion statement, the DSA development at Pantex Plant has been driven DOE STD 3009. The subject matter experts brought into Pantex Plant for DSA development have never made an accommodation for the NEWS Program. This lack of accommodation was driven by the drumbeat that 10 CFR 830 replaced the NEWS Program and by contracts saying be in compliance with DOE STD 3009. The claim is that DOE STD 3009-compliant accident scenario development and control effectiveness evaluation can be achieved by one set of controls (i.e., who needs the 2<sup>nd</sup> Stinking NES Standard!). Hence Attachment 4 of Supplement Directive 452.2B (NNSA SD 452.2B), the second sentence of paragraph 4 has the following lead-in, "While it is not a NESSG function to evaluate the accuracy and completeness of safety basis

documentation, ..." and this phrase is generally referred to as, "The NESSG is not the HAR police."

After twenty years of the NEWS program exclusion statement removal and full implementation of the rule at Pantex Plant, I have found there might be some usefulness in the Weapon Response Summary document which promulgates the Design Agency (DA) weapons response rules to the Production Plant Contractor (PPC). I have found the engineers in W-10 to be punctilious, but they bloviate because their weapons response rules are handed over to snollygosters. The HARs produced by the snollygosters are circumlocutory. I contend that the DSA at Pantex Plant is much like the lamppost to a drunk, it is there more for support than for illumination. So, if the NESSG is NOT the HAR police, who are the HAR police? I wish to meet them to learn how to make a citizen's arrest!

## 5.0 ONE-POINT SAFETY

Please see "Memo-XTD-1-11-005.pdf" titled *On the Interpretation of DOE Orders for MPS Options (U)*.

## 6.0 CONCLUSION

From W-NES-23-0004U,

"... LANL's nuclear explosive operational review is in your [W-NES] capable hands, and you [W-NES] have a great LANL Nuclear Explosive Safety Study Group (NESSG) cohort.

LANL's nuclear detonation safety design implementation is in Anthony Puckett's [Q-18] capable hands, and he [Q-18] has some great cohorts as well.

I was fortunate to be LANL's NES project leader when the X Theoretical Design (XTD) Division stood up the Safety and Surety Team with Mike Burkett as the team leader and to participate in that team becoming the group that it is now. I think Erik Shores is doing a great job as the Safety and Surety Group (XTD-SS) group leader. ..."

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<sup>i</sup> Nuclear Explosive Safety History at Pantex Plant, Ken Pierce, circa 1993.

<sup>ii</sup> DoD Nuclear Weapons Surety Program, DoD Directive 3150.02, April 24, 2013.

Incorporating Change 5, July 15, 2022

<sup>iii</sup> Multi-Unit Processing and the 2<sup>nd</sup> Nuclear Explosive Safety Standard, LA-CP-02-0597, Tommy Morris, January 3, 2003.

<sup>iv</sup> "All models are wrong, some are useful" is a common aphorism attributed to George E. P. Box, circa 1976, Journal of the American Statistical Association, 71 (356): 791–799.

<sup>v</sup> Nuclear Explosive Safety Study of Offsite Transportation, October 7, 2021, Art Trujillo – Chair.

<sup>vi</sup> This paragraph is copied from NESS of Offsite Transportation, October 7, 2021, Art Trujillo – Chair.

<sup>vii</sup> Ibid.

<sup>viii</sup> Approximately the same time as 10 CFR 830 removed the NEWS exclusion statement, NNSA was born (i.e., circa 2000). A few years after NNSA was formed, a massive reorganization changed the Albuquerque Operations Manager's Responsibilities and split the NNSA AL Operations Manager responsibilities between what is now NA-12 and NPO manager. (The NNSA reorganization also eliminated the Nevada Operations Office but much, if not all, of the NOO Manager responsibilities stayed with the Nevada Site Manager—my assessment is that the politics that led to the NNSA reorganization was politics between NNSA HQ and then NNSA AL Operations Manager Rick Glass, who left NNSA after the reorganization).

<sup>ix</sup> § 830.204 of 10 CFR 830.

<sup>x</sup> I substituted "Nuclear Explosive" for "Criticality" from actual 10 CFR 830 words in § 830.204 b.